

[Evaluation Standard]

(Releasing Property)

- A: No problem occurs throughout the whole evaluation temperature range.
- B: Slight tendency of twisting is found depending on the temperature, but there is
- 5 substantially no problem.
- C: A temperature where releasing cannot be conducted is present.

(Uniformity of Solid Image)

- A: Completely no image unevenness is found.
- B: Slight image unevenness is found, but there is no practical problem.
- 10 C: Some image unevenness is found but is in the allowable level.
- D: Considerable image unevenness is found and is not allowable.

In the invention employing the constitution described in the foregoing, the followings are realized even when the oilless fixing process is employed. Both the fixing releasing property and the transferring and developing properties can be

15 achieved; the lowest fixing temperature can be decreased; the high temperature offset can be prevented; and good image preservation property can be obtained, whereby an image of good quality can be provided.

The entire disclosure of Japanese Patent Application No. 2000-268679 filed on September 5, 2000 including specification, claims and abstract is incorporated

20 herein by reference in its entirety.

WHAT IS CLAIMED IS:

1. A toner for developing an electrostatic image comprising a resin, a colorant and a releasing agent, wherein the toner has protrusions having a height of approximately  $0.05\text{ }\mu\text{m}$  to  $2\text{ }\mu\text{m}$  on the surface thereof, a part of the protrusions contain  
5 the releasing agent inside thereof, and the toner is characterized by a ratio of an element derived from the releasing agent to the elements on the surface of the toner determined by X-ray photoelectron spectroscopy, the element ratio being smaller than 10 % by atom.

10 2. The toner for developing an electrostatic image as claimed in claim 1, wherein the protrusions have a height of approximately from  $0.1$  to  $1\text{ }\mu\text{m}$ .

15 3. The toner for developing an electrostatic image as claimed in claim 1, wherein at least the part of the protrusions containing the releasing agent inside are formed by migration of the releasing agent.

4. The toner for developing an electrostatic image as claimed in claim 1, wherein the releasing agent in the protrusions has an acicular form.

20 5. The toner for developing an electrostatic image as claimed in claim 1, wherein the toner particles have a surface property index of approximately 2.0 or less which is measured under the condition of the toner without external additive, the surface property index being defined by the following equations:

(Surface property index) =

(Measured specific surface area)/(Calculated specific surface area)

09884090-06078860  
102780-081701

Sub  
B3

25

Sub  
9/6/02  
A

33  
32  
33

20  
10  
20  
30  
40  
50  
60  
70  
80  
90  
100  
110  
120  
130  
140  
150  
160  
170  
180  
190  
200  
210  
220  
230  
240  
250  
260  
270  
280  
290  
300  
310  
320  
330  
340  
350  
360  
370  
380  
390  
400  
410  
420  
430  
440  
450  
460  
470  
480  
490  
500  
510  
520  
530  
540  
550  
560  
570  
580  
590  
600  
610  
620  
630  
640  
650  
660  
670  
680  
690  
700  
710  
720  
730  
740  
750  
760  
770  
780  
790  
800  
810  
820  
830  
840  
850  
860  
870  
880  
890  
900  
910  
920  
930  
940  
950  
960  
970  
980  
990  
1000  
1010  
1020  
1030  
1040  
1050  
1060  
1070  
1080  
1090  
1100  
1110  
1120  
1130  
1140  
1150  
1160  
1170  
1180  
1190  
1200  
1210  
1220  
1230  
1240  
1250  
1260  
1270  
1280  
1290  
1300  
1310  
1320  
1330  
1340  
1350  
1360  
1370  
1380  
1390  
1400  
1410  
1420  
1430  
1440  
1450  
1460  
1470  
1480  
1490  
1500  
1510  
1520  
1530  
1540  
1550  
1560  
1570  
1580  
1590  
1600  
1610  
1620  
1630  
1640  
1650  
1660  
1670  
1680  
1690  
1700  
1710  
1720  
1730  
1740  
1750  
1760  
1770  
1780  
1790  
1800  
1810  
1820  
1830  
1840  
1850  
1860  
1870  
1880  
1890  
1900  
1910  
1920  
1930  
1940  
1950  
1960  
1970  
1980  
1990  
2000  
2010  
2020  
2030  
2040  
2050  
2060  
2070  
2080  
2090  
2100  
2110  
2120  
2130  
2140  
2150  
2160  
2170  
2180  
2190  
2200  
2210  
2220  
2230  
2240  
2250  
2260  
2270  
2280  
2290  
2300  
2310  
2320  
2330  
2340  
2350  
2360  
2370  
2380  
2390  
2400  
2410  
2420  
2430  
2440  
2450  
2460  
2470  
2480  
2490  
2500  
2510  
2520  
2530  
2540  
2550  
2560  
2570  
2580  
2590  
2600  
2610  
2620  
2630  
2640  
2650  
2660  
2670  
2680  
2690  
2700  
2710  
2720  
2730  
2740  
2750  
2760  
2770  
2780  
2790  
2800  
2810  
2820  
2830  
2840  
2850  
2860  
2870  
2880  
2890  
2900  
2910  
2920  
2930  
2940  
2950  
2960  
2970  
2980  
2990  
3000  
3010  
3020  
3030  
3040  
3050  
3060  
3070  
3080  
3090  
3100  
3110  
3120  
3130  
3140  
3150  
3160  
3170  
3180  
3190  
3200  
3210  
3220  
3230  
3240  
3250  
3260  
3270  
3280  
3290  
3300  
3310  
3320  
3330  
3340  
3350  
3360  
3370  
3380  
3390  
3400  
3410  
3420  
3430  
3440  
3450  
3460  
3470  
3480  
3490  
3500  
3510  
3520  
3530  
3540  
3550  
3560  
3570  
3580  
3590  
3600  
3610  
3620  
3630  
3640  
3650  
3660  
3670  
3680  
3690  
3700  
3710  
3720  
3730  
3740  
3750  
3760  
3770  
3780  
3790  
3800  
3810  
3820  
3830  
3840  
3850  
3860  
3870  
3880  
3890  
3900  
3910  
3920  
3930  
3940  
3950  
3960  
3970  
3980  
3990  
4000  
4010  
4020  
4030  
4040  
4050  
4060  
4070  
4080  
4090  
4100  
4110  
4120  
4130  
4140  
4150  
4160  
4170  
4180  
4190  
4200  
4210  
4220  
4230  
4240  
4250  
4260  
4270  
4280  
4290  
4300  
4310  
4320  
4330  
4340  
4350  
4360  
4370  
4380  
4390  
4400  
4410  
4420  
4430  
4440  
4450  
4460  
4470  
4480  
4490  
4500  
4510  
4520  
4530  
4540  
4550  
4560  
4570  
4580  
4590  
4600  
4610  
4620  
4630  
4640  
4650  
4660  
4670  
4680  
4690  
4700  
4710  
4720  
4730  
4740  
4750  
4760  
4770  
4780  
4790  
4800  
4810  
4820  
4830  
4840  
4850  
4860  
4870  
4880  
4890  
4900  
4910  
4920  
4930  
4940  
4950  
4960  
4970  
4980  
4990  
5000  
5010  
5020  
5030  
5040  
5050  
5060  
5070  
5080  
5090  
5100  
5110  
5120  
5130  
5140  
5150  
5160  
5170  
5180  
5190  
5200  
5210  
5220  
5230  
5240  
5250  
5260  
5270  
5280  
5290  
5300  
5310  
5320  
5330  
5340  
5350  
5360  
5370  
5380  
5390  
5400  
5410  
5420  
5430  
5440  
5450  
5460  
5470  
5480  
5490  
5500  
5510  
5520  
5530  
5540  
5550  
5560  
5570  
5580  
5590  
5600  
5610  
5620  
5630  
5640  
5650  
5660  
5670  
5680  
5690  
5700  
5710  
5720  
5730  
5740  
5750  
5760  
5770  
5780  
5790  
5800  
5810  
5820  
5830  
5840  
5850  
5860  
5870  
5880  
5890  
5900  
5910  
5920  
5930  
5940  
5950  
5960  
5970  
5980  
5990  
6000  
6010  
6020  
6030  
6040  
6050  
6060  
6070  
6080  
6090  
6100  
6110  
6120  
6130  
6140  
6150  
6160  
6170  
6180  
6190  
6200  
6210  
6220  
6230  
6240  
6250  
6260  
6270  
6280  
6290  
6300  
6310  
6320  
6330  
6340  
6350  
6360  
6370  
6380  
6390  
6400  
6410  
6420  
6430  
6440  
6450  
6460  
6470  
6480  
6490  
6500  
6510  
6520  
6530  
6540  
6550  
6560  
6570  
6580  
6590  
6600  
6610  
6620  
6630  
6640  
6650  
6660  
6670  
6680  
6690  
6700  
6710  
6720  
6730  
6740  
6750  
6760  
6770  
6780  
6790  
6800  
6810  
6820  
6830  
6840  
6850  
6860  
6870  
6880  
6890  
6900  
6910  
6920  
6930  
6940  
6950  
6960  
6970  
6980  
6990  
7000  
7010  
7020  
7030  
7040  
7050  
7060  
7070  
7080  
7090  
7100  
7110  
7120  
7130  
7140  
7150  
7160  
7170  
7180  
7190  
7200  
7210  
7220  
7230  
7240  
7250  
7260  
7270  
7280  
7290  
7300  
7310  
7320  
7330  
7340  
7350  
7360  
7370  
7380  
7390  
7400  
7410  
7420  
7430  
7440  
7450  
7460  
7470  
7480  
7490  
7500  
7510  
7520  
7530  
7540  
7550  
7560  
7570  
7580  
7590  
7600  
7610  
7620  
7630  
7640  
7650  
7660  
7670  
7680  
7690  
7700  
7710  
7720  
7730  
7740  
7750  
7760  
7770  
7780  
7790  
7800  
7810  
7820  
7830  
7840  
7850  
7860  
7870  
7880  
7890  
7900  
7910  
7920  
7930  
7940  
7950  
7960  
7970  
7980  
7990  
8000  
8010  
8020  
8030  
8040  
8050  
8060  
8070  
8080  
8090  
8100  
8110  
8120  
8130  
8140  
8150  
8160  
8170  
8180  
8190  
8200  
8210  
8220  
8230  
8240  
8250  
8260  
8270  
8280  
8290  
8300  
8310  
8320  
8330  
8340  
8350  
8360  
8370  
8380  
8390  
8400  
8410  
8420  
8430  
8440  
8450  
8460  
8470  
8480  
8490  
8500  
8510  
8520  
8530  
8540  
8550  
8560  
8570  
8580  
8590  
8600  
8610  
8620  
8630  
8640  
8650  
8660  
8670  
8680  
8690  
8700  
8710  
8720  
8730  
8740  
8750  
8760  
8770  
8780  
8790  
8800  
8810  
8820  
8830  
8840  
8850  
8860  
8870  
8880  
8890  
8900  
8910  
8920  
8930  
8940  
8950  
8960  
8970  
8980  
8990  
9000  
9010  
9020  
9030  
9040  
9050  
9060  
9070  
9080  
9090  
9100  
9110  
9120  
9130  
9140  
9150  
9160  
9170  
9180  
9190  
9200  
9210  
9220  
9230  
9240  
9250  
9260  
9270  
9280  
9290  
9300  
9310  
9320  
9330  
9340  
9350  
9360  
9370  
9380  
9390  
9400  
9410  
9420  
9430  
9440  
9450  
9460  
9470  
9480  
9490  
9500  
9510  
9520  
9530  
9540  
9550  
9560  
9570  
9580  
9590  
9600  
9610  
9620  
9630  
9640  
9650  
9660  
9670  
9680  
9690  
9700  
9710  
9720  
9730  
9740  
9750  
9760  
9770  
9780  
9790  
9800  
9810  
9820  
9830  
9840  
9850  
9860  
9870  
9880  
9890  
9900  
9910  
9920  
9930  
9940  
9950  
9960  
9970  
9980  
9990  
10000

(Calculated specific surface area) =

$$6\Sigma(n \times R^2)/(\rho \times \Sigma(n \times R^3))$$

wherein n represents a number of particles in a channel of a Coulter Counter, R represents a channel particle diameter in the Coulter Counter, and  $\rho$  represents a toner density.

6. The toner for developing an electrostatic image as claimed in claim 5, wherein the surface property index is in the range of about from 1.0 to 1.8.

7. The toner for developing an electrostatic image as claimed in claim 1, wherein the toner has an external additive added to a surface of the toner particles, and the external additive has an average primary particle diameter of about 0.2  $\mu\text{m}$  or less, and the external additive is added in an amount of about from 1 to 3 parts by weight per 100 parts by weight of the toner.

8. The toner for developing an electrostatic image as claimed in claim 1, wherein the toner has a volume average particle diameter ( $D_{50}$ ) of about from 2 to 10  $\mu\text{m}$ .

9. The toner for developing an electrostatic image as claimed in claim 1, wherein the toner has a shape factor SF1 of about from 100 to 140, the SF1 being defined by the following equation:

$$\text{SF1} = (\text{ML}^2/\text{A}) \times (\pi/4) \times 100$$

wherein ML represents a maximum length of the toner particles, and A represents a projected area of the toner particles.

10. The toner for developing an electrostatic image as claimed in claim 1, wherein the toner has a volume average particle size distribution index GSDv of about 1.25 or less, the GSDv being defined by the following equation:

5 
$$\text{GSDv} = (D_{84v}/D_{16v})^{0.5}$$

wherein  $D_{84v}$  represents a diameter ( $\mu\text{m}$ ) at which the volume accumulated particle distribution becomes 84%, and  $D_{16v}$  represents a diameter ( $\mu\text{m}$ ) at which the volume accumulated particle distribution becomes 16%.

10 ~~11. The toner for developing an electrostatic image as claimed in claim 1, wherein the releasing agent is selected from the group of polyethylene wax, paraffin wax, Fischer-Tropsch wax and nitrogen containing wax.~~

15 12. A developer for developing an electrostatic image, the developer comprising a toner and a carrier, wherein the toner has protrusions having a height of approximately  $0.05 \mu\text{m}$  to  $2 \mu\text{m}$  on the surface thereof, a part of the protrusions contain a releasing agent inside thereof, and a ratio of an element derived from the releasing agent to the elements on the surface of the toner determined by X-ray photoelectron spectroscopy, the element ratio being smaller than 10 % by atom.

20 13. The developer as claimed in claim 12, wherein the toner particles have a surface property index of approximately 2.0 or less which is measured under the condition of the toner without external additive.

340  
9/6/02  
A

35  
34  
35

14. The developer as claimed in claim 12, wherein the toner has a volume average particle size distribution index GSDv of about 1.25 or less.

15. A process for producing the toner for developing an electrostatic  
5 image claimed in claim 1, the process comprising:

mixing at least a resin particle dispersion and a releasing agent dispersion to prepare an aggregated particle dispersion;

heating the aggregated particle dispersion to form the toner particles; and

10 forming protrusions on a surface of the toner by migration of the releasing agent.

16. The process as claimed in claim 15, wherein the step of heating the aggregated particles dispersion comprises an intermediate step of heating at a temperature in a range of  $\pm 20^{\circ}\text{C}$  from the melting point of the releasing agent, for 2 to  
15 10 hours.

17. A process for forming an image, comprising:  
forming an electrostatic latent image on an electrostatic image holding member;

20 developing the electrostatic latent image with the developer as claimed in claim 12 on a developer holding member to form a toner image;  
transferring the toner image to a transfer material; and  
fixing the toner image on the transfer material.

25 18. The process as claimed in claim 17, further comprising:

300  
9/04/02  
A

36  
35  
36

recovering the toner remaining on the electrostatic image holding member and reusing the toner in the developing step.

19. The process as claimed in claim 17, wherein the transferring step  
5 comprises a step of transferring the toner image to an intermediate transfer material, and a step of transferring the toner image to a final transfer material.

20. The process as claimed in claim 17, wherein the fixing step employs an oilless fixing process.

09384090-081701

10

yes  
9/6/02  
A

37  
~~37~~  
37